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First record of the Delicate Salt Flat Mouse, *Salinomys delicatus* Braun & Mares, 1995 (Rodentia, Cricetidae) in a xeric environment of northwestern Córdoba (Argentina), with comments on its conservation status

Julián Mignino[1*], Andrea del Pilar Tarquino-Carbonell[2], Agustina A. Ojeda[3], Pablo Teta[4]

1 Instituto de Antropología de Córdoba (IDACOR), Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Museo de Antropología, Departamento de Antropología, Facultad de Filosofía y Humanidades, Universidad Nacional de Córdoba, Córdoba, Argentina • julianmignino@ffyh.unc.edu.ar https://orcid.org/0000-0002-9404-0155

2 Laboratorio de Filogeografía, Taxonomía Integrativa y Ecología (LFTIE), Instituto Argentino de Investigaciones de las Zonas Áridas (IADIZA), CCT CONICET Mendoza, Argentina • atarquino@mendoza-conicet.gob.ar https://orcid.org/0000-0003-0007-7537

3 Laboratorio de Filogeografía, Taxonomía Integrativa y Ecología (LFTIE), Instituto Argentino de Investigaciones de las Zonas Áridas (IADIZA), CCT CONICET Mendoza, Argentina • agustinao@mendoza-conicet.gob.ar https://orcid.org/0000-0003-2007-5061

4 División Mastozoología, Museo Argentino de Ciencias Naturales Bernardino Rivadavia, Buenos Aires, Argentina • antheca@yahoo.com.ar https://orcid.org/0000-0001-8694-0498

* Corresponding author

Abstract. *Salinomys delicatus* Braun & Mares, 1995 is a sigmodontine rodent endemic to perisaline environments in west-central Argentina. It is currently considered to be a Vulnerable species due to its patchy distribution and the loss of optimal habitats caused by intensive anthropogenic activities. In this work, we document the first record for this species in the Dry Chaco ecoregion of northwestern Córdoba province (Argentina), enlarging the geographic distribution of this species by approximately 115 km to the east of previously known occurrences. Our new record highlights the need to strengthen conservation policies in the Dry Chaco of Córdoba province.

Keywords. Sigmodontinae, dry Chaco, central Argentina, conservation, perisaline area

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Introduction

The South American continent contains a high diversity of small mammal species inhabiting tropical, highland, coastal, and continental arid dry biomes (Morello 1958; Ojeda et al. 2000). One of these specialized small mammals is the Delicate Salt Flat Mouse, *Salinomys delicatus* Braun & Mares, 1995, an uncommon sigmodontine rodent endemic to west-central Argentina, whose distribution, natural history, and population dynamics are poorly known (Rodríguez et al. 2012, 2019; Pardiñas et al. 2021). *Salinomys delicatus* is ecophysiologically adapted to arid and semiarid environments, inhabiting the edges of salt flats, generally associated to forest patches and hard soils between 300 and 700 m a.s.l. (Braun and Mares 1995; Ojeda et al. 2001; Lanzone et al. 2005, 2011; López 2020; Ochoa et al. 2021; Pardiñas et al. 2021). Based mostly on its fragmentary distribution and loss of optimal environments by intensive anthropogenic activities, this species was recently classified as Vulnerable in the Red List of Mammals of Argentina (Rodríguez et al. 2019).

To date, 13 localities of occurrence are known for

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this species (Fig. 1). Originally referred to San Luis and San Juan provinces, subsequent authors have enlarged the geographic distribution of *S. delicatus* both to the north and south. Ojeda et al. (2001) reported this species from La Rioja province, extending its distribution by about 250 km north from the limits suggested by Braun and Mares (1995). Later, Lanzone et al. (2005) extended the distribution approximately 270 km northwest to Catamarca province. Lanzone et al. (2005) also reported for the first time its karyotype. Later, Lanzone et al. (2011) documented the first occurrence of *S. delicatus* in Mendoza province (see also Rodriguez et al. 2012). Subsequent authors have provided additional records in Mendoza and San Luis, which helped fill the gap between the previous ones (López 2020; López et al. 2021; Ochoa et al. 2021). Recently, Pardiñas et al. (2021) cited the first record of *S. delicatus* from La Pampa province, extending this species' geographical range approximately 450 km to the south.

Here, we report for the first time the presence of *S. delicatus* in the Dry Chaco ecoregion of Córdoba province. We extend this species' distributional limits and elevational range and discuss its conservation status.

Methods

During July 2019 as part of a research project on the diet of owls, we recorded the presence of fragmentary mandibular remains of *Salinomys delicatus* in pellets of burrowing owls, *Athene cunicularia* (Molina, 1782). Samples of pellets were collected at northwest Córdoba province (permits for collection resolution number no. 410/2019 Secretaría de Gobierno, de Ambiente y Desarrollo Sustentable (SGAYDS)). The sampling area covered more than 100 km^2 and included the survey and analysis of eight nests of *A. cunicularia*. Small-mammal remains were identified using comparative collections from the Museo de Antropología de Córdoba (MDA) and specimens from the Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" and bibliographic sources (Braun and Mares 1995; Patton et al. 2015; Pardiñas et al. 2021).

The landscape in this area is part of the Dry Chaco ecoregion. Rainfall in the Dry Chaco biome is restricted to an area surrounded by mountains that act as a natural barrier, and there is a marked seasonal difference between wet (November–April) and dry (May–October) periods (Karlin et al. 2020). The average precipitation in the coldest and driest months (2013–2018) was 74.2 mm, while in the warmer wet season the average was 424.5 mm. The vegetation is characterized by halophytic shrubs such as the jumes *Heterostachys ritteriana* (Moq.) Ung.-Sternb. and *Allenrolfea patagonica*

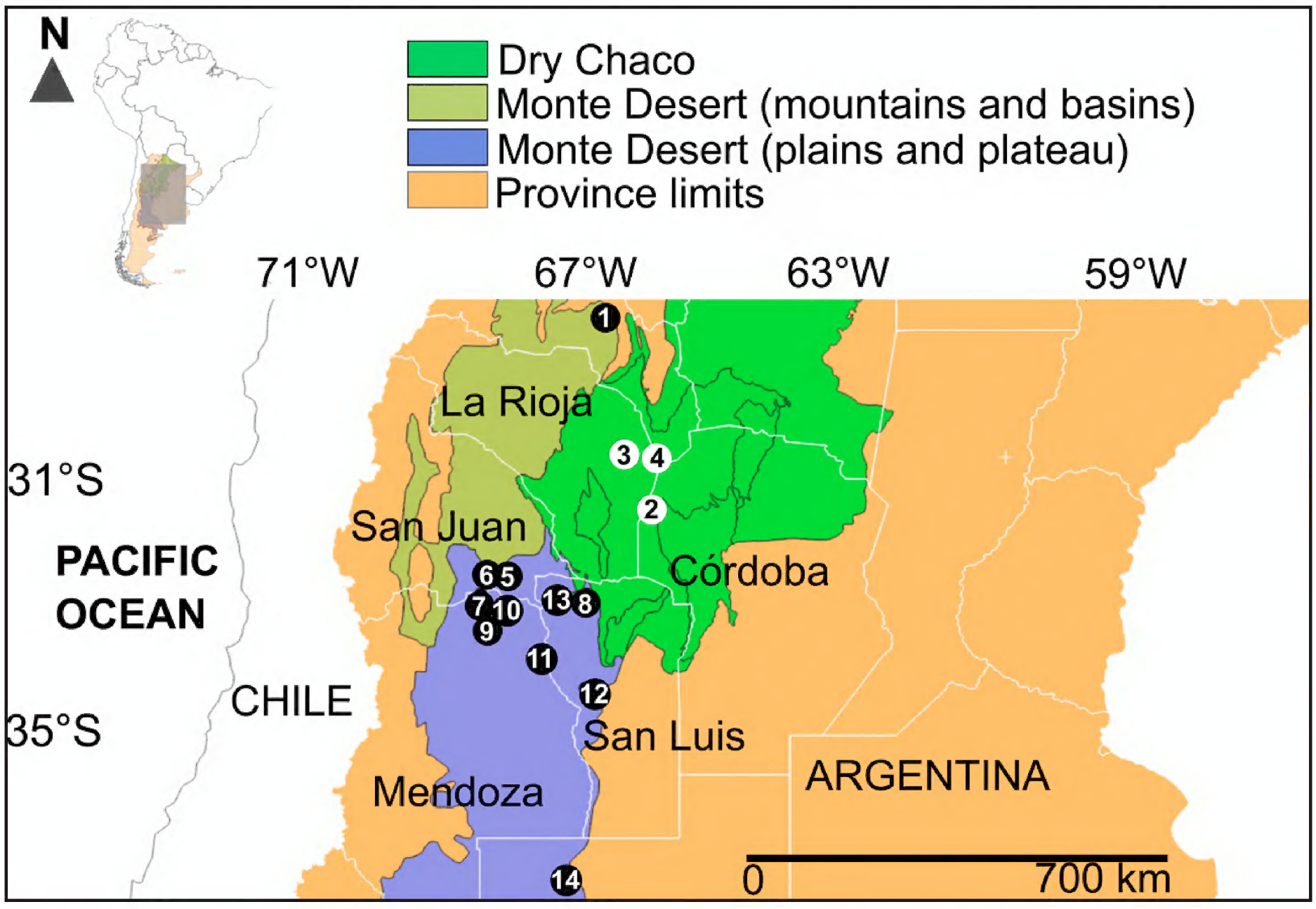

Figure 1. Previous records for *Salinomys delicatus* in Argentina and the new record for Córdoba Province (2). Localities: 1) Salar de Pipanaco; 2) Estancia La Providencia; 3) Salar La Antigua; 4) 426 km SW Quimilo, Salinas Grandes; 5) 15 km E José Marti; 6) 6 km N km 514 de Ruta 20; 7) Laguna del Rosario; 8) Pampa de las Salinas; 9) San José; 10) Reserva Natural Bosques Telteca; 11) Estancia El Tapón; 12) 15 km SSE Salinas del Bebedero; 13) Parque Nacional Sierra de las Quijadas; 14) Paso de los Algarrobos. The white lines are provincial borders.

(Moq.) Kuntze), the jarillas *Larrea cuneifolia* Cav. and *L divaricata* Cav., and trees such as Algarrobo Negro *Neltuma nigra* (Griseb.) C.E. Hughes & G.P. Lewis, Quebracho Blanco *Aspidosperma quebracho-blanco* Schltdl., and brea *Parkinsonia praecox* (Ruiz & Pav. ex Hook.) Hawkins (Fig. 2; Cabido et al. 2018).

Results

New record. ARGENTINA – Córdoba • Departamento Minas; 30°54′31.1″S, 065°33′22.0″W; 248 m alt; 1.VII.2019; leg. J. Mignino; 2 adult specimens, sex unknown; MDA-001-3 and MDA-002-3.

Among the studied samples, we found two individuals referable to *S. delicatus*, which were represented by two left and two right and one left and one right dentaries. The remains of *S. delicatus* were recovered along with Sigmodontinae [*Akodon dolores* Thomas, 1916 and *Graomys* cf. *G. chacoensis* (Allen, 1901)], Ctenomyidae [*Ctenomys* Blainville, 1826], Octodontidae [*Tympanoctomys* Yepes, 1942], and Caviidae rodents [*Microcavia maenas* (Thomas, 1898)], and Didelphidae marsupials [*Thylamys* sp. Gray, 1843] (Table 1).

Identification. Morphological diagnostic characters of *S. delicatus* included a well-developed masseteric knob ending in a pronounced masseteric tubercle, which is visible even in lingual view (Fig. 3A); a well-excavated condyloid process (Fig. 3B); and flexids of the first lower molar closed by a well-developed cingulum (Fig. 3C).

Discussion

We document the first record of the Delicate Salt Flat Mouse, *Salinomys delicatus*, from the dry Chaco ecoregion of northwestern Córdoba province (Argentina), which enlarges this species' geographic distribution by approximately 115 km east of its previously known occurrences. Previous localities for *S. delicatus* are shown in Figure 1. Our new record highlights the need to expand and intensify biodiversity surveys in arid and semiarid areas of Argentina, especially in poorly prospected portions of the Dry Chaco ecoregion (Núñez-Regueiro et al. 2015; Periago et al. 2017). This assertion was also supported by the recent finding of *Tympanoctomys* sp. (Mignino et al. 2021), a caviomorph rodent specialist of xeric environments, occurring in this same area as *S. delicatus*.

The conservation status of *S. delicatus* has recently been assessed as Vulnerable (Rodriguez et al. 2019). This category is the product of the scarce knowledge about the distribution and demography of this rodent, plus its characterization as a habitat specialist and identified threats in some areas where it occurs (e.g. the expansion of olive plantations; Rodriguez et al. 2019). Globally, *S. delicatus* has been assessed as Data Deficient (Pardiñas and Jayat 2019), which appears contradictory, as this rodent is endemic to Argentina and both its national and global conservation status should be similar. Based on this contradiction, and the data provided by some recently published contributions, we think that the conservation status of this mouse needs to be reevaluated. First, new records for *S. delicatus* have been continuously reported since its description, almost three decades ago (Braun and Mares 1995). Second, suitable habitats for this species encompass large areas in arid and semiarid portions of west-central Argentina (Rodríguez et al. 2019). Third, this rodent seems to be moderately abundant in some parts of Mendoza and San Luis, including some protected areas (Rodríguez et al. 2012; Ochoa et al. 2021). Fourth, the use of Data Deficient is explicitly discouraged by the International Union for the Conservation of the Nature (Teta et al. 2021).

The extent of occurrence (EOO) of *S. delicatus* is larger than 160,000 km^2, exceedingly more than eight

Figure 2. Typical shrubland landscape at the study area. **A.** Shrubs and trees (*Atriplex lampa*, *Senna aphylla*, *Maytenus vitis-ideaea* and *Aspidosperma quebracho blanco*). **B.** *Larrea cuneifolia shrubs*.

Table 1. Micromammals found in pellets of *Athene cunicularia* from the estancia La Providencia, Córdoba. Abbreviations: Minimum number of individuals and their frequency (MNI, %MNI).

Taxa	MNI	%MNI
Didelphimorphia	—	—
Didelphidae		
Thylamys sp.	2	4.16
Rodentia	—	—
Caviidae	—	—
Microcavia maenas	1	2.08
Cricetidae	—	—
Akodon dolores	2	4.16
Graomys cf. *chacoensis*	22	45.83
Salinomys delicatus	2	4.16
Octodontidae	—	—
Tympanoctomys sp.	2	4.16

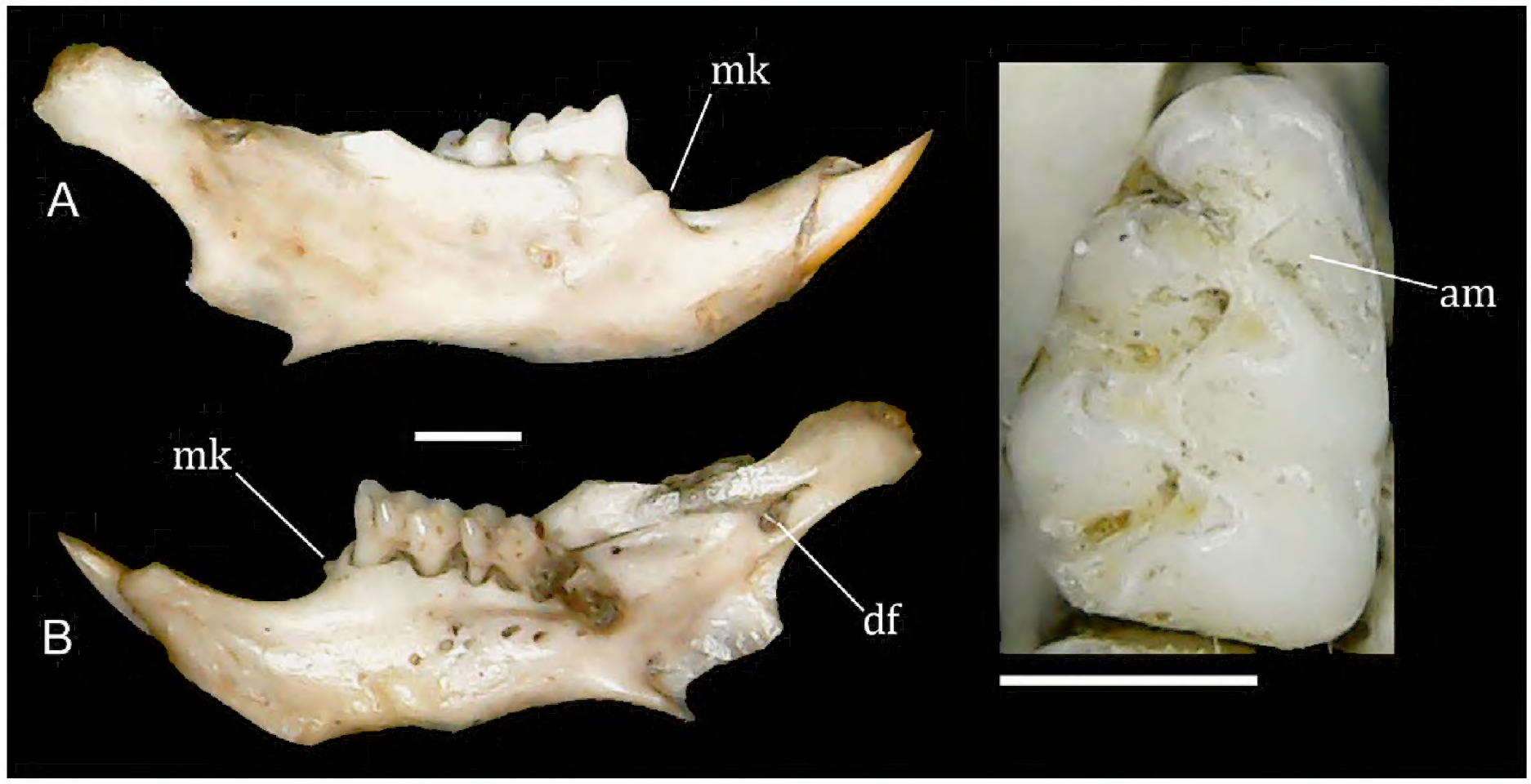

Figure 3. Mandibular remains of *Salinomys delicatus* (MDA-001-3) found in La Providencia (Córdoba, Argentina). **A.** Right dentary in labial view. **B.** Right dentary in lingual view. **C.** Right m1 in occlusal view. Abbreviations: messeteric knob (mk), dental foramen (df), anterior murid (am). Scale bars: 1 mm.

times the threshold for EOO (20,000 km^2) under criterion B1 for its recognition as Vulnerable following IUCN Red List criteria (IUCN 2021). If we accept the EOO, then *S. delicatus* might be Least Concern. However, we know that this species is a habitat specialist and not evenly distributed; so, EOO may not provide the best distributional estimate and area of occupancy (AOO) may be more useful. Currently, we do not know the AOO of this species, but based on the profusion of salt basins in west-central Argentina, AOO is likely well above the threshold of 2000 km^2 under criterion B2, Vulnerable. At best, this species may be Near Threatened, based on its relatively fragmented distribution as a habitat specialist, endemicity, and the rapid loss of habitat due to the expansion of agriculture (e.g. soybean) in the Chaco region. However, with the evidence at hand, this species is most likely Least Concern, as has been suggested by Formoso and Teta (2021; see also Pardiñas et al. 2021). Ongoing research including ecological niche modelling and population genetics studies will help to clarify the conservation status of this species.

Other species found in the study area include *Graomys* cf. *G. chacoensis*, a generalist species, usually associated to complex environments that in some parts of its distribution has been favored by anthropogenic activities such as agriculture, livestock, logging, and forest fires (Teta et al. 2014). Rimondino (2016) documented a deterioration of the forest vegetation cover in the study area and found a higher prevalence of bare ground, shrubs, isolated trees, and grassland patches. Rimondino interpreted this change as a potential consequence of logging during the 1990s and a large-scale forest fire in 1994. This could explain the high frequency of a generalist and opportunistic species, like *Graomys* cf. *G. chacoensis* (48.83% of total MNI), versus those with more specialized ecological requirements such as *S. delicatus* and *Tympanoctomys* sp.

Finally, we suggest the urgent need for increased support of expanding our knowledge of the Chaco fauna (Karlin et al. 2020), given the increasing defaunation of the Chaco environment due to advancing agricultural and urban frontiers at the expense of the natural ecosystems (Periago et al. 2015). Additional sampling, through traditional trapping methods, are also needed to obtain whole individuals, which would includi skeletons, tissues, and karyotypes. The records of *S. delicatus* (this work) and *Tympanoctomys* (Mignino et al. 2021) also highlight the importance of continuing sampling of small mammals over time (see also Jayat et al. 2016; Teta et al. 2016). In this way, the continuity of research in the area will provide a better understanding of the population dynamics of both species and allow for the development of better conservation strategies for them. Additional needs include infrastructure, such as biological stations, and sustained financial support, which would provide the necessary conditions to establish long-term field research programs.

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Author Contributions

Conceptualization: PT, APTC, JM, AO. Data curation: APTC, AO, PT. Funding acquisition: JM, AO. Investigation: JM, AO, APTC, PT. Supervision: PT, AO. Writing –original draft: AO, PT, APTC, JM. Writing – review and editing: APTC, AO, PT, JM.

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